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LOFT (Large Observatory For X-ray Timing): a candidate X-ray mission for the next decade

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(see http://www.isdc.unige.ch/loft/index.php/loft-team/community-members)

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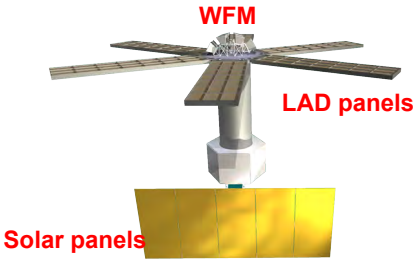
Abstract. LOFT is one of the four medium mission candidates (M3), selected by ESA in the framework of the Cosmic Vision Programme (2015-2025), for feasibility study. If approved by ESA in 2014, its launch is foreseen in 2022-2024. LOFT is being designed to observe X-ray sources with excellent temporal resolution and very good spectral capability. Its main objectives are to directly probe the motion of matter in the very close vicinity of black holes (Strong Field Gravity), as well as to study the physics of ultra dense matter (Neutron Stars). The payload includes a **Large Area Detector (LAD)** and a **Wide Field Monitor (WFM)**. The LAD is a collimated (< 1 degree field of view) experiment operating in the energy range 2-30 keV, with a 10 m^2 peak effective area and an energy resolution of 260 eV at 6 keV. The WFM will operate in almost the same energy range than the LAD, 2-50 keV, enabling simultaneous monitoring of a few-steradian wide field of view, with an angular resolution of < 5 arcmin. In addition to its main scientific objectives, LOFT will also do a complete plan of observatory science, studying with unprecedented detail in the 2-80 keV range several transient phenomena, like accreting white dwarfs in cataclysmic variables, novae in outburst (internal and external shocks in the ejecta in classical novae, and shocks with the wind of the companion in symbiotic recurrent novae) and post-outburst novae (once accretion is re established).

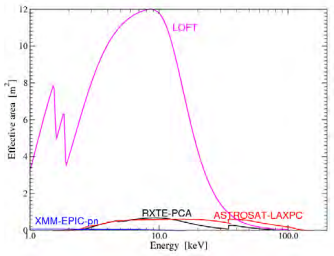
LOFT description

In Figure 1 we show a scheme of the LOFT satellite, with the LAD and WFM instruments, together with a detailed view of the configuration of the WFM, with its 10 coded mask based cameras. The effective area of the LAD instrument, as compared with that of previous similar instruments flown is also shown (an improvement by a factor of 20 at E=10 keV is expected), as well as the WFM field of view - depicted as the projected effective area in galactic coordinates. The performances of the two instruments for LOFT, LAD and WFM, are shown in Figure 2.

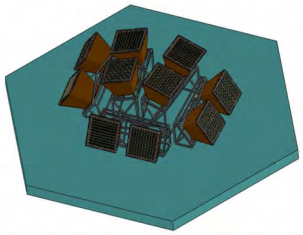
The main scientific topics of LOFT are related to the theme "Matter under extreme conditions", of the ESA Cosmic Vision Programe 2015-2025
(see Figure 3 and http://www.isdc.unige.ch/loft/ for details).
The equation of state of Neutron Stars and the behavior of matter under strong field gravity (i.e., mainly matter accreting onto Black Holes) are the main scientific topics. In addition, LOFT will do what we call "Observatory Science" (see Figure 4), one topic being the observation of the hard X-ray emission from classical and recurrent novae, related to the shocks between the ejecta and the circumstellar matter. This topic is



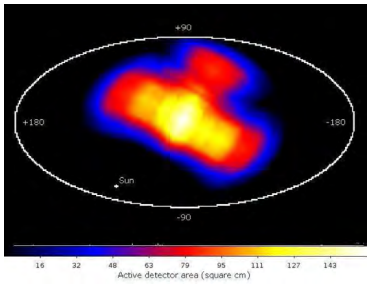
Schematic view of LOFT



LAD effective area compared to other instruments: 20 times larger than RXTE/PCA at 8 keV



The Wide Field Monitor (WFM)
The 10 coded mask cameras (5 units) are arranged in the optical bench to catch good triggering sources for the LAD and many transient/bursting sources



Projected effective area of the WFM in galactic coordinates

Figure 1. LOFT satellite and the WFM (left panels). Effective area of the LAD and of the WFM (right panels)

especially relevant to understand the recently discovered "Fermi novae", emitting in the GeV range. RS Oph (2006 eruption) would have been detected by the Fermi/LAT instrument; the information obtained by RXTE in 2006 was crucial to make this prediction. With LOFT, such a study would have been much more precise (see Figure 4 and paper by Hernanz in this same volume).

A list of selected papers related to LOFT is presented in the references section.

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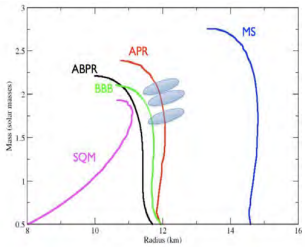
Parameter	Value (LAD)
Energy range	2-80 keV (30-80 keV larger energy binning)
Effective Area	10 m^2 (@8 keV)
Field of View	≤1°
Energy resolution	≤260 eV at 6 keV (EOL)
Time resolution	~7μs
Dead-time	≤1% for 1 Crab source
Background	~10 mCrab
Maximum average source flux	500 mCrab
Maximum peak source flux	15 Crab

Parameter	Value (WFM)
Energy Range	2-50 keV (50-80 keV extended)
Geometric Area (5 cameras)	1820 cm^2
Peak Effective Area (on-axis)	>80 cm^2
Energy Resolution FWHM@6 keV	< 500 eV (EOL at -30°C)
Field of View at Zero Response	180° x 90° + 90°x90° toward night hemisphere
Angular Resolution	5′
Point Source Location Accuracy (10σ)	1′
On-axis sensitivity at 5σ in 3 s (Galactic Center)	270 mCrab
On-axis sensitivity at 5σ in 58 ks (1 day observation of the Galactic Center)	2.1 mCrab

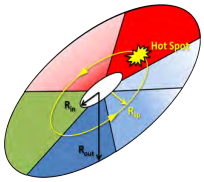
Figure 2. Performance of the LOFT instruments: LAD and WFM

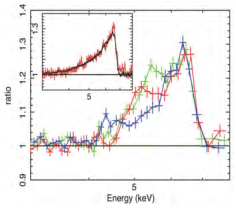
ESA's Cosmic Vision Theme *"Matter under extreme conditions"*

LOFT Core Science Goals (~50% of observing time)



Constrain the Equation of State of Neutron Stars, by measuring their M and R





Strong gravitational fields - BH mass and spin
Phase resolved spectroscopy of the Fe-K line from a hot spot on a Black Hole accretion disk

Figure 3. Main themes of the LOFT core science

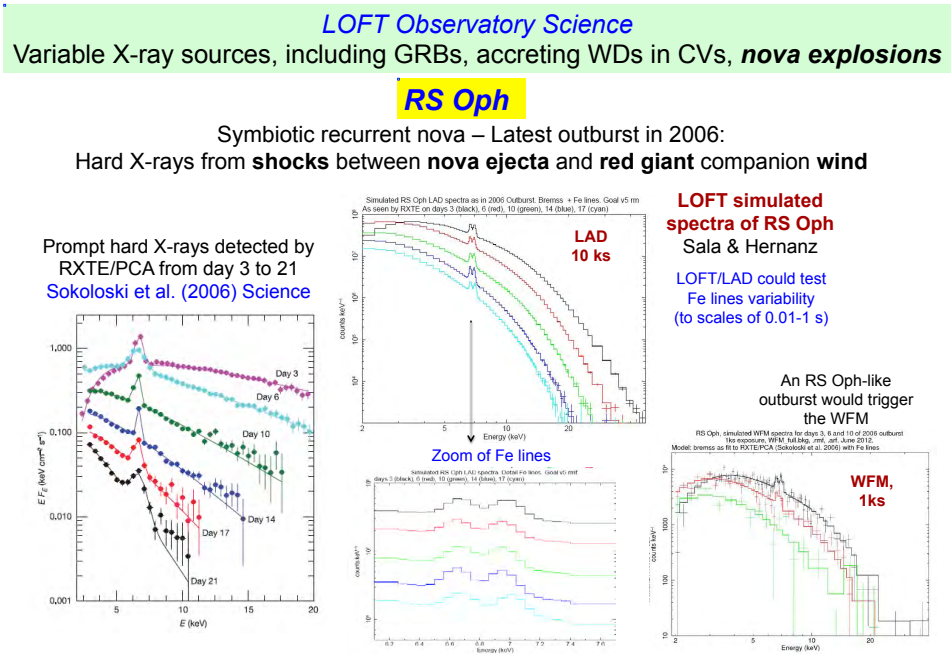


Figure 4. An example of LOFT observatory science: recurrent novae

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Zane, S., et al. 2012, "A Large Area Detector Proposed for LOFT, the Large Observatory for X-ray Timing", in SPIE Conf. Ser., 8443-87